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# A Computational Study of the Influence of Boattail Plates on the Trailer Flowfield

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## Several approaches are being used to simulate the GTS

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### SNL

Reynolds Average Navier-Stokes (RANS)/ **Detached Eddy Simulation (DES)**  
Compressible Finite Volume Code  
Average “Steady” Solution/**Unsteady Solution**  
Widely used - may not predict drag correctly

### LLNL

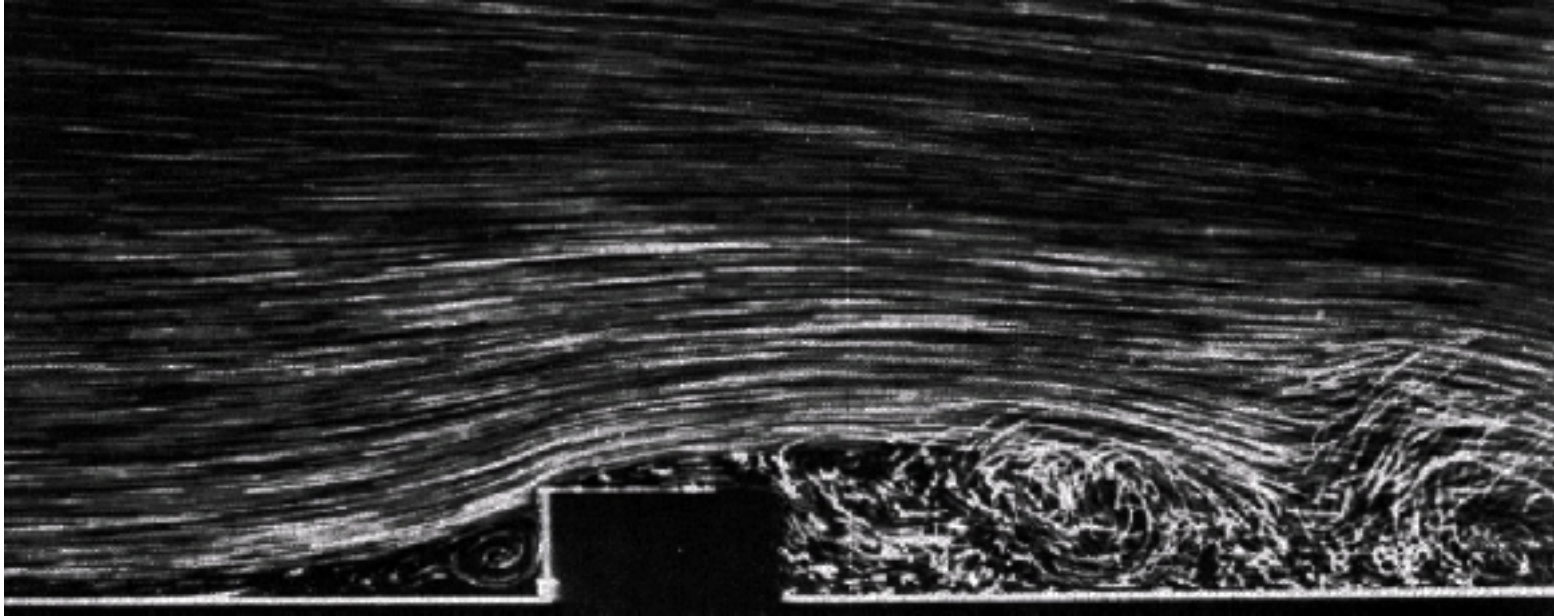
Large Eddy Simulation (LES)  
Compressible Finite Element Code  
Unsteady Solution of large scales/approximation of the small scales  
Computationally intensive

### Caltech

Direct Numerical Simulation/ **LES**  
Vortex Method  
Gridless  
In development

## Turbulent flow contains eddies ranging from large-scale to small-scale

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**Large-eddy simulation captures the large-scale motion and approximates the small-scale motion.**

all turbulent motions = large-scale motions + small-scale motions

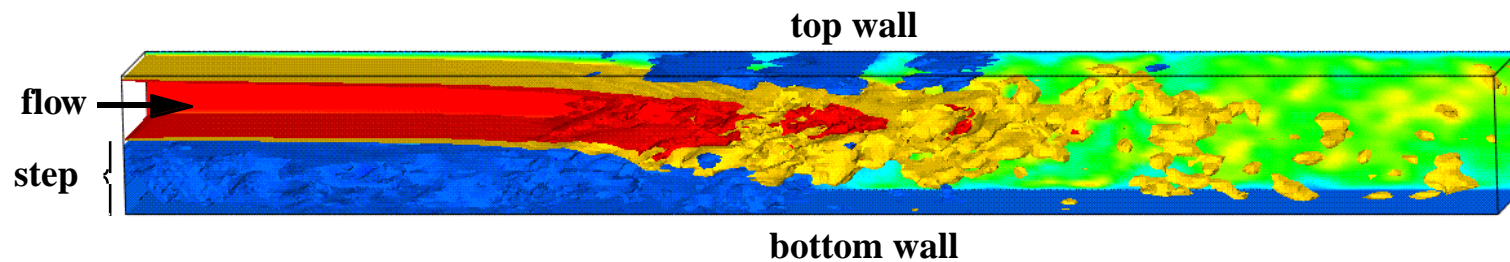
= 'resolved' scale + 'subgrid' scale

$$u_{\alpha} = \bar{u}_{\alpha} + u'_{\alpha}$$

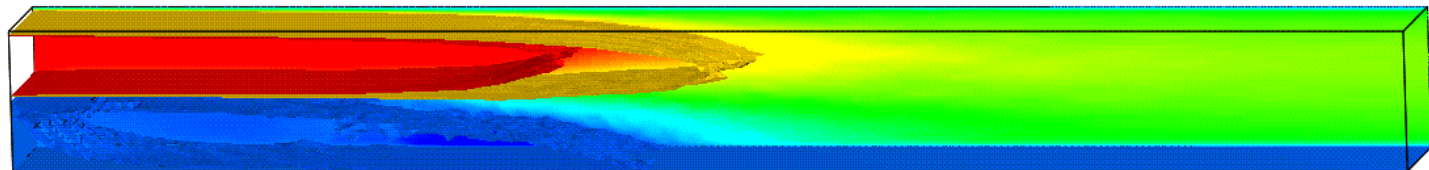


## Streamwise Velocity

**LES: instantaneous and/or time-averaged with 1 empirical parameter**



**RANS: only time-averaged with many empirical parameters**



## **We are focusing on two areas**

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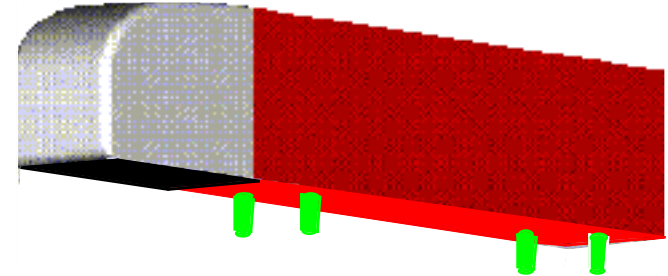


### **Simulating full GTS geometry**

**NASA 7'x10' wind tunnel tests**

**Course mesh ~ 6 million elements**

**Results will be validated with experiments**



### **Effect of boattail plates on aerodynamic drag reduction**

**Modeling only back end to conserve elements**

**Geometry based on GTS model**

**Investigating fundamental flow phenomenon**

## **Boattail plates have been shown to reduce drag**

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**Full-scale truck in wind tunnel**



**Model in wind tunnel**

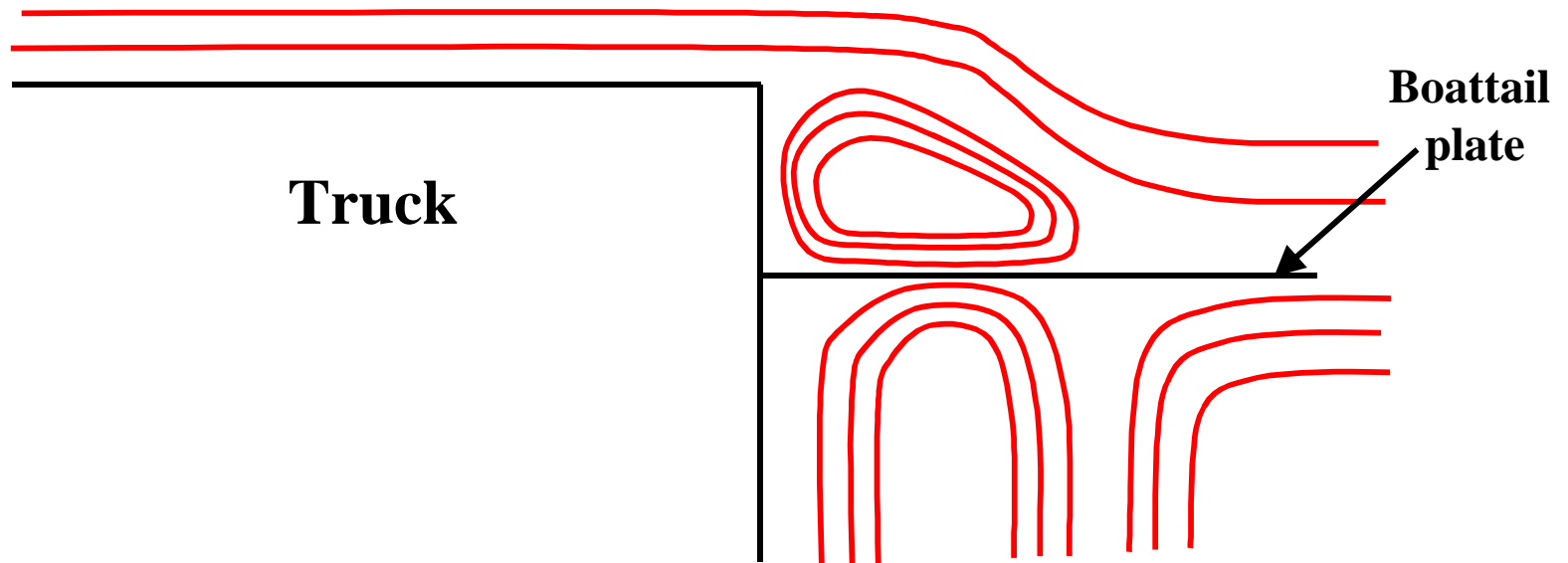


**Plates developed by Continuum Dynamics, Inc.**

## A recirculation zone forms in the boattail plate offset



This recirculation zone draws the wake in behind the body

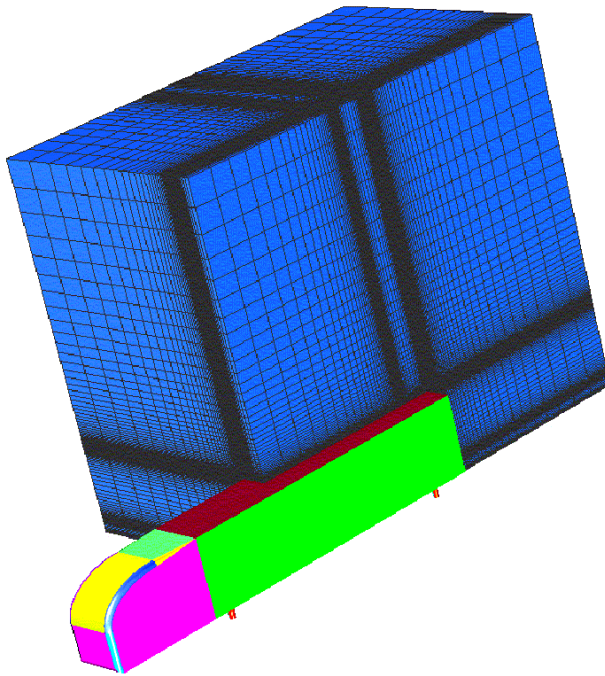


# Solving the 3D turbulent flow field requires extensive computational resources

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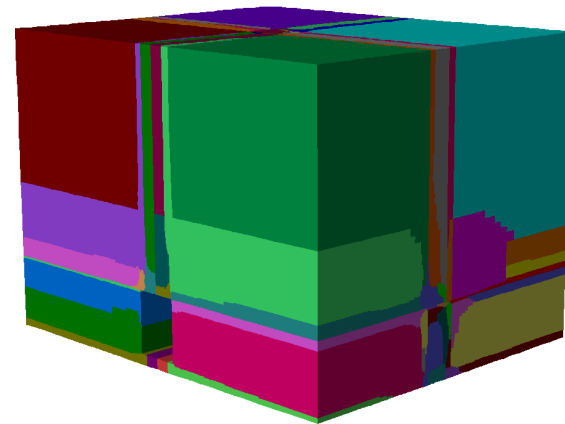
**Compressible flow simulation**



**Half of 3 million  
element grid**

**148 computational domains**

**148 processors on ASCI Blue  
massively parallel machine  
(IBM)**



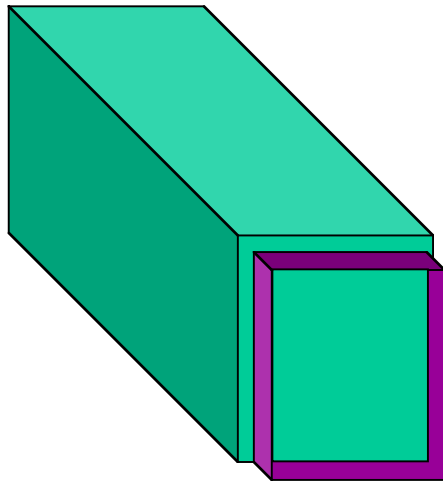
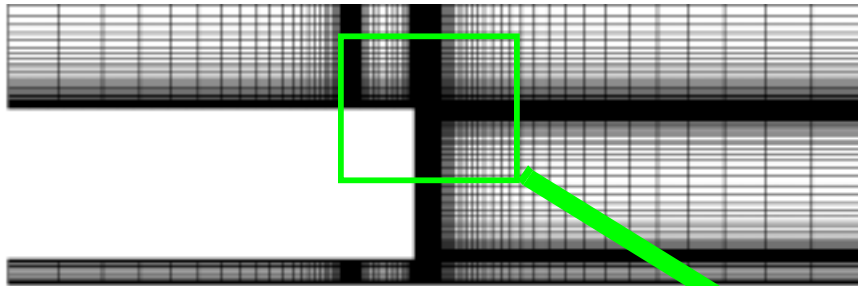
**Domain decomposition**



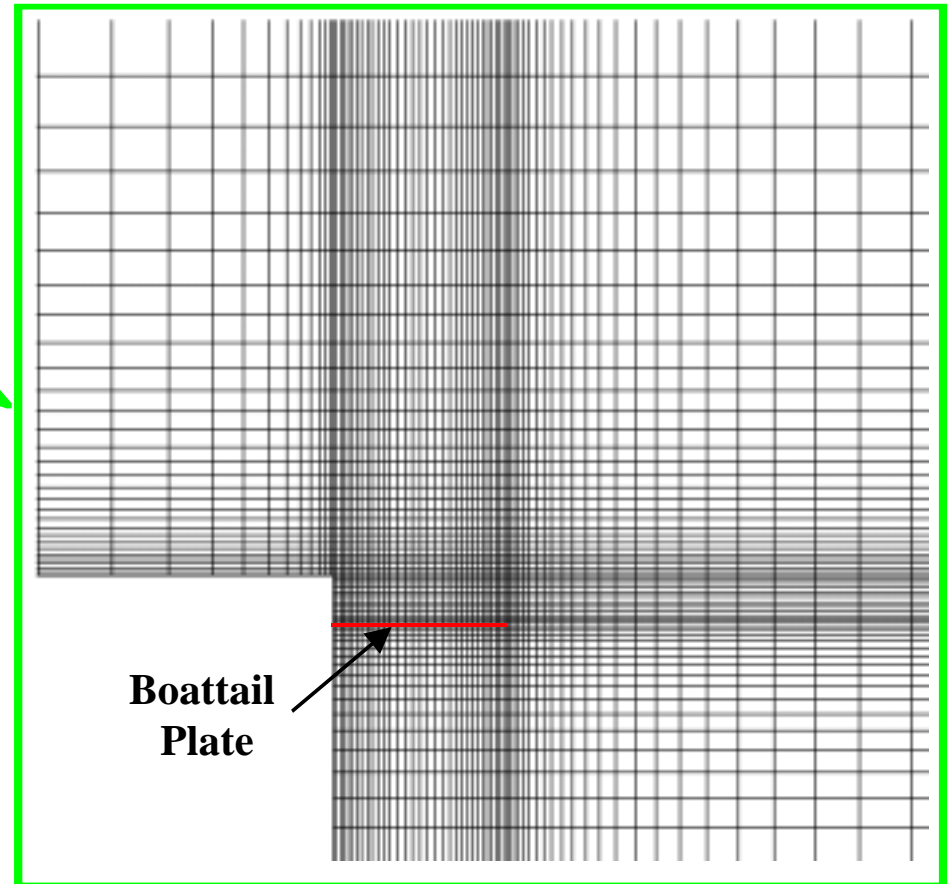
**The problem size is approximately 3 million elements  
with 1 mm wall resolution**



**Grid on rear of trailer**



**Refinement at walls and plates**



**Resolution of the wall determines the time step**

# Computations predict the reduced wake size as seen in experiments

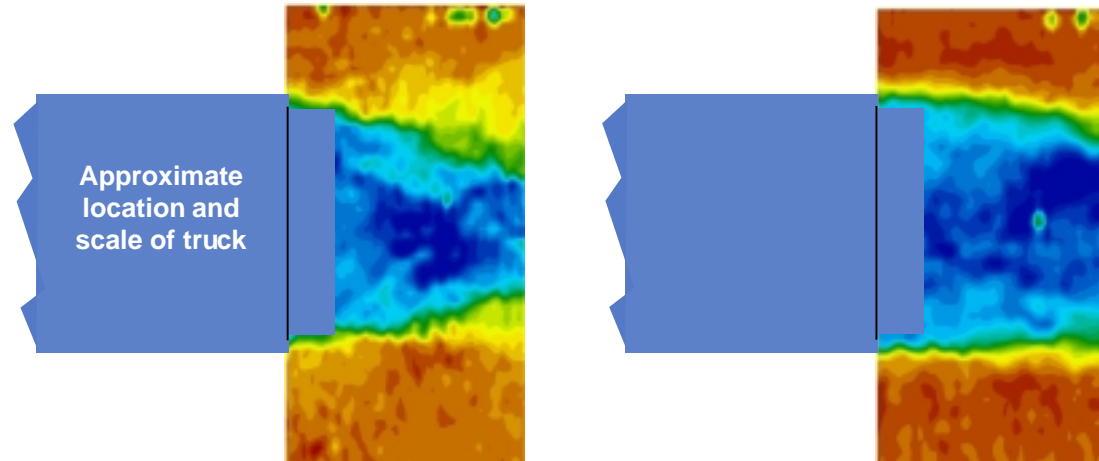


## Top View: Streamwise velocity component

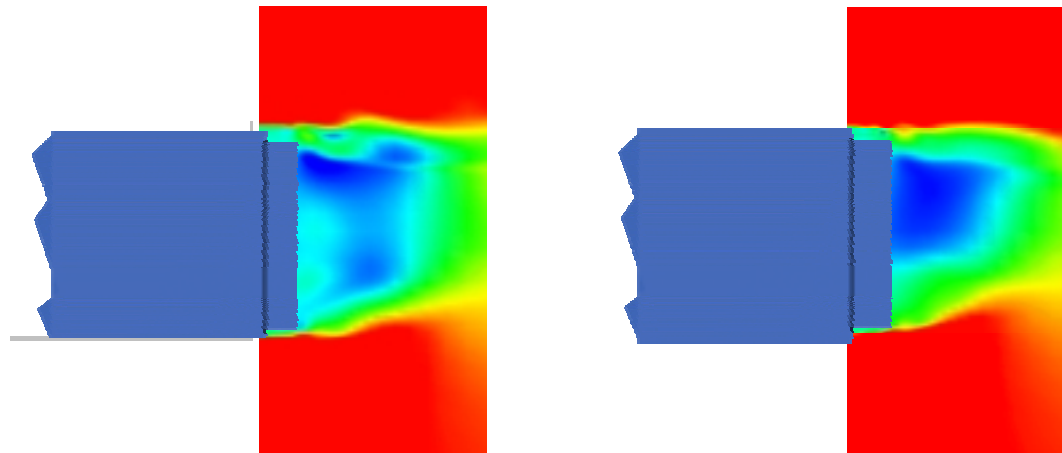
Without plates

With plates

Experiment



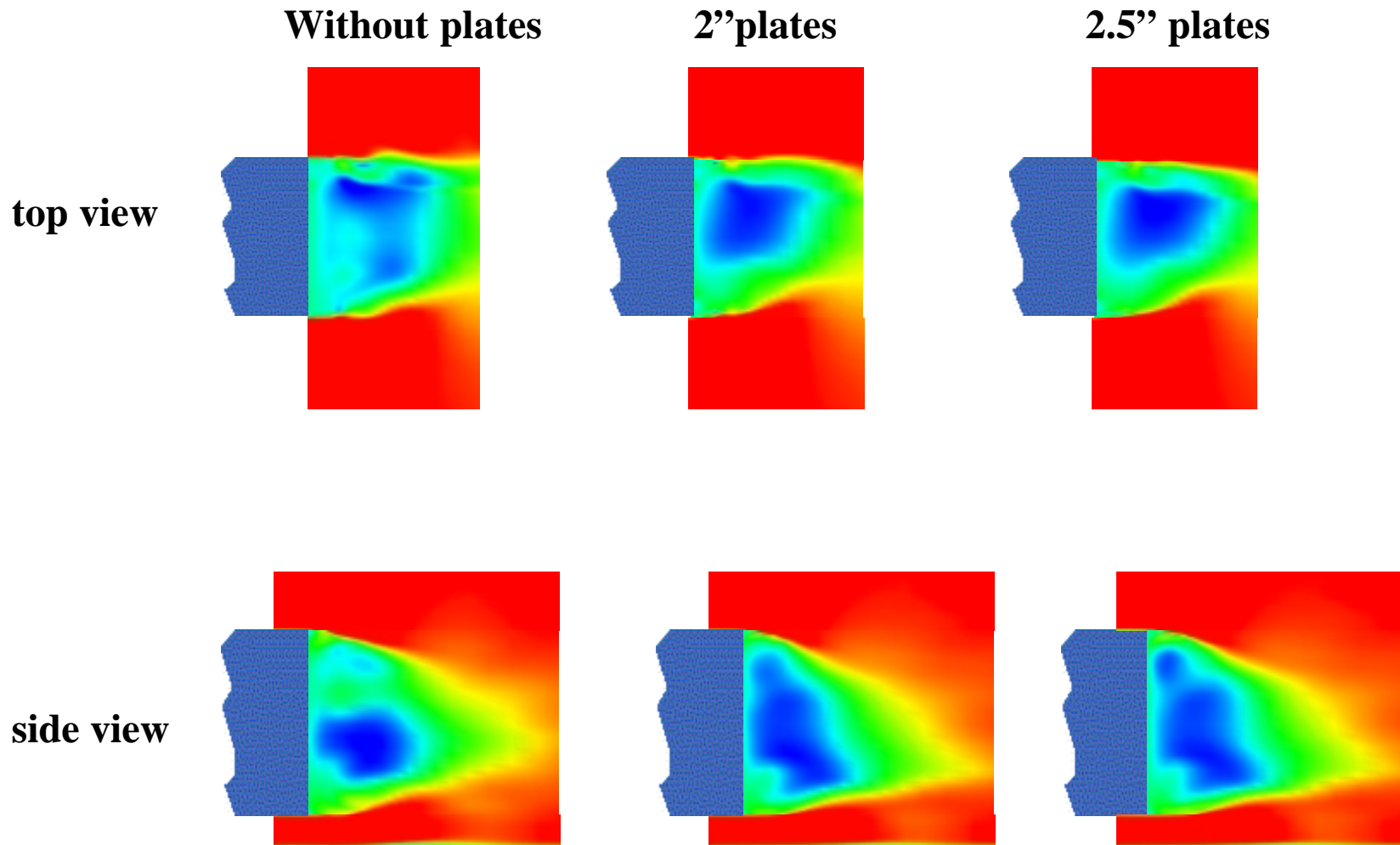
Computations



# Effect of boattail plate length is being studied



## Streamwise Velocity Component



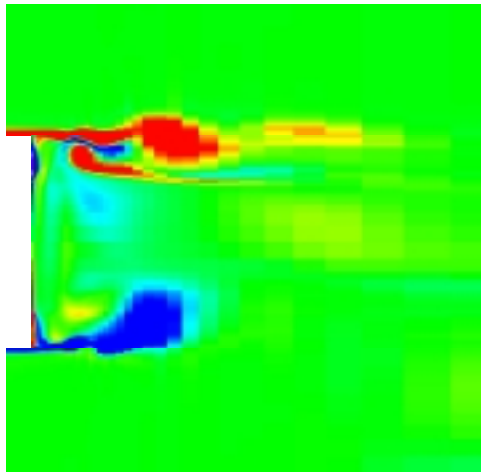
# Out of plane vorticity in trailer wake

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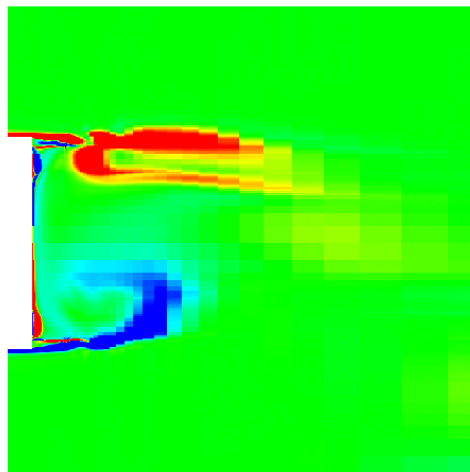


## Top View

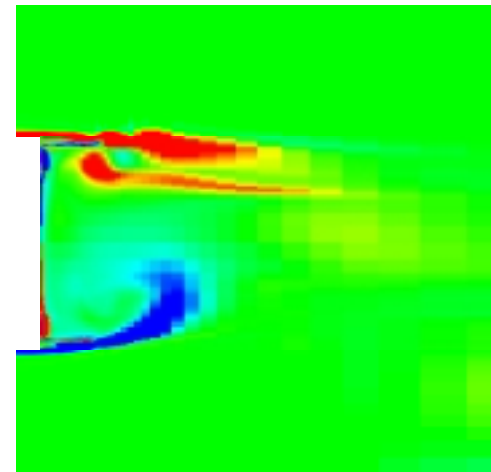
Without plates



2" plates



2.5" plates



## Summary

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**Boattail plates have been shown experimentally to reduce drag**

**FEM/LES is being used to understand the flow phenomena and the effect of plate length**

**Preliminary results indicate similar trends as the experiments**

**Validation of simulations with experiments is ongoing**